A Blending Algorithm for Atmospheric Refractivity Using 1-Dimensional Boundary Layer Modeling

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One general practice in modeling radio frequency (RF) propagation in the atmosphere, using weather forecast model results, is to pad a surface layer refractivity profile to the model-derived refractivity profile for obtaining a complete refractivity profile from the surface to the top of the atmosphere. The full 3-D mesoscale forecast models, such as the Coupled Ocean/Atmosphere Mesoscale Prediction System (COAMPS®), does not explicitly represent the marine atmospheric surface layer (MASL) especially in the lowest 20 m or so, which is where the evaporative duct occurs. There is, hence, the need to use a diagnostic evaporative duct model, such as the Navy Atmospheric Vertical Surface Layer Model (NAVSLaM), to produce an independent representation of the evaporation duct based on the 3-D model's results in the lowest level(s). The procedure of stitching two profiles together is generally referred to as 'blending'. Different blending schemes exist in the community, but a thorough evaluation of the results is needed.

A similar requirement exists when using refractivity profiles from rawinsonde observations for simulating propagation through the measured atmosphere. Although rawinsondes measurements starts at the ship deck level, the lowest 10s of meters of the atmosphere near the ship are disturbed by the ship wake. Still, the lowest 10s of meters in the measured refractivity profiles need to come from evaporation duct models and to be blended to the observed sounding profile.

We developed a 'blending' technique that can be used to extend the measured or model refractivity profiles down to the surface layer to include the evaporation duct. The basic framework used COAMPS in a single column mode with very high vertical resolution and thus capable of resolving the evaporation duct. We also modified the boundary layer mixing portion of COAMPS boundary layer parameterization so that the model can represent the surface layer mixing following Monin-Obukhov Similarity Theory (MOST). This method is referred to as the Single Column Model (SCM) Blending Algorithm (SCMBA). As with any boundary layer model, large-scale forcing needs to be specified, which is not always available. Here we ran SCMBA, using a nudging technique, that nudged the SCM to follow the modeled or measured profiles above a designated level above the MASL. In this manner, the boundary layer and surface layer evolved forward in time, within the model, to which the turbulent mixing shaped the surface layer and resulting upper boundary layer gradually moved towards the modeled or measured profiles.

In this presentation, results from the new blending scheme will be compared to observed refractivity profiles from tethered balloon-based measurements onboard small boats, an effort of the Coupled Air-Sea Processes and Electromagnetic ducting Research (CASPER) project. The small boat measurements provide the first opportunities to evaluate any evaporation model using in-situ measurements. Blending results from SCMBA, using COAMPS profiles, will also be compared to those using blending schemes currently used in US Navy's operation.